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Uncertainty, risk, and opportunity frames in Australian online media reports of the 2016 Great Barrier Reef mass coral-bleaching event

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Abstract: Through a content analysis, this research aimed to discover how frequently the linguistic frames of scientific uncertainty, skepticism, risk, and opportunity were used in 224 Australian online news reports of the 2016 Great Barrier Reef mass coral-bleaching event, which virtually all climate scientists attribute to climate change. During this event, 29% of shallow-water coral died. Particularly, the research aimed to determine how often the frame of *explicit risk* was used compared to the other frames since explicit risk is considered by many to be the most honest and effective frame for communicating climate change. In this frame, the word "risk" is used and the odds, probabilities, or chance of something adverse happening to an asset are given. It is used commonly by people in business and the military. Reports were taken from six outlets: The *Australian, Courier Mail*, and *Townsville Bulletin*, each of which is owned by News Corp, and the *Sydney Morning Herald* (*SMH), ABC*, and *Guardian* Australia edition. When comparing the outlets, skepticism was most dominant in the News Corp reports. In contrast, the opportunity frame was most dominant in the *Guardian* (47%) and *ABC* reports (30%), followed by scientific uncertainty in the *SMH* reports (40%). Across all the outlets, the explicit risk frame had the lowest salience (3%) and dominance (4%). It is recommended that journalists receive more training in using the explicit risk frame for reporting on actual and predicted climate change events.

ABOUT THE AUTHORS

Marilyn Mitchell lectures in Mass Communication, Communication Research, and Organizational Communication at Bond University in Australia. She has past experience in environmental consulting and has published training materials on environmental management in the United States and Australia. She is interested in principles of visual and verbal representation and has published in *Visible Language, Sign System Studies, Cogent Social Sciences, Australasian College of Road Safety*, and *International Journal of Literacies*.

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PUBLIC INTEREST STATEMENT

Analyzing media reports about the risks of climate change including coral bleaching events on the Great Barrier Reef is important as media have the potential to shape public understanding and response. This research analyzed 224 Australian online news reports of the 2016 bleaching from six different outlets to see how the event was explained using the different linguistic frames of scientific uncertainty, skepticism, disaster or implicit risk, explicit risk, and opportunity. Of all the frames, the one that many believe to be the most honest and effective for climate change communication is explicit risk, which is used by business people and insurers to persuade others to protect different assets. With this frame, the word "risk" appears and the odds, probabilities or chance of something adverse happening to the asset are given. As found in this research, the explicit risk frame was little used (9%). More training for journalists is recommended.

Subjects: Mass Communication; Risk Communication; Environmental Communication

Keywords: climate change; risk communication; Great Barrier Reef; coral bleaching; environmental journalism

1. Introduction

Valued at $56 billion AU to the year 2050 as an Australian "economic, social and iconic asset" (Deloitte Access Economics, 2017), the Great Barrier Reef (GBR) in 2016 experienced its most damaging mass coral-bleaching event on record (AIMS, 2016). The coral became bleached when it was stressed by "rising sea surface temperatures owing to global warming" (Hughes et al., 2017, p. 373) that were "amplified by a strong El Nino" (Great Barrier Reef Marine Park Authority (GBRMPA), 2017, p. iv). During the event, the northernmost section of the reef experienced mass bleaching for the first time (NOAA Coral Reef Watch, 2017) and "an average of 29% of shallow-water coral" died (GBRMPA, 2017, p. 24). Regarding global warming, 97% of climate science experts overwhelmingly agree that humans are causing it, which means that humans hold responsibility for the 2016 bleaching (Cook et al., 2016). Although the reef faces many threats such as crown-of-thorns starfish and agricultural runoff, scientists consider global warming or climate change due to greenhouse gas (GHG) emissions to be the greatest (Commonwealth of Australia, 2015). The reef and all reefs globally are at risk from climate change.

To reduce the potential for further bleaching events and maintain the reef, scientists strongly urge nations to provide much greater action on climate change by reducing GHGs (GBRMPA, 2017). One way of motivating such action is through the media, which provide an important source of information (Cabecinhas, Lazaro, & Carvalho, 2008) and may shape public understanding and response (Hansen, 2016; Lakoff, 2010). It is obvious, however, that simply presenting scientific information about climate change and its effects on the GBR in the media is not enough to shift all people, and particularly the dominant group, to action (Hansen, 2016), although it is nonetheless important for the media to explain the science. Painter (2013) believes that a more effective way to shift attitudes and behavior about climate change is to frame it as an explicit risk rather than as uncertain or as fearful and leading to disaster. The language of explicit risk is expected to be most effective among those who already use it such as business and military people. Therefore, this research contributes to that of Painter (2013) by providing a content analysis of uncertainty, risk and opportunity reporting of the 2016 coral-bleaching event across six online Australian news outlets: the *Australian*, the *Courier Mail*, the *Townsville Bulletin*, the *Sydney Morning Herald, ABC News*, and the *Guardian* Australia edition. Underlying this research is the idea that journalists should receive the best possible guidance for reporting coral bleaching and other aspects of climate change so that people can make better choices on how to respond. The research allows for greater understanding of how the bleaching event was reported in Australia, and for comparison of reporting across the outlets to determine how each publisher framed the situation. In addition to examining the frames used, the research examines how frequently each outlet presented the bleaching story from a scientific perspective. Further, the research contributes to knowledge regarding what occurs in media reports when a climate-change event actually occurs in a media-polarized country. The GBR mass coral-bleaching event occurred right within Australian coastal and territorial waters, and carried the potential to affect the country's economy and global image.

2. Literature review

Hansen's (2016) research on the history of accuracy in the public communication of science found that media reports of climate change are politically framed, and that therefore, not everyone will agree with scientists' assessment of the cause of or appropriate response to coral bleaching. The traditional concept of accurate science reporting has shifted from a linear model in which scientists at the top communicate to the public at the bottom, to a model of "communication as the exercise of power, that is the power to define and frame issues in terms of what they are, who is responsible, and how to move them forward" (p. 764). Ulrich Beck (2013) noted that in modern societies, "a new moral climate of politics [has developed] … in which cultural… evaluations play a

central role and arguments for and against real or possible consequences of technical and economic decisions are publicly conducted" (p. 6). Therefore, in making decisions about climate change and its effects on the reef, it is less taken as a given that scientific expertise will dominate or even be considered.

Before continuing, it is helpful to define framing. As described by Lakoff (2010), a frame is a usually unconscious structure for thinking about things and includes "semantic roles, relations between roles, and relations to other frames" (p. 71). For example, a school frame includes the roles of teacher, student, principal, parents, classroom, library, gym, etc. and specifications for what happens at a school such as teachers training students to read and write. As Lakoff (2010) noted, "All thinking and talking [and writing] involves 'framing'" (p. 72). Framing highlights certain aspects of a problem while masking others, thereby affecting interpretations of the problem (Dutton & Ashford, 1993). Frames also include emotions, which as noted by Lakoff (2010), make information meaningful to people.

As described by Painter (2013), four different uncertainty and risk frames are typically used in climate change reporting: (1) scientific uncertainty, which includes skepticism about climate science; (2) implicit risk or disaster due to climate change; (3) explicit risk or language that uses terms such as "risk," "probability," or "chance" along with numbers or percentages to explain the adverse impacts of climate change (e.g. loss of 64,000 jobs); and (4) opportunity, which may refer, for example, to how an economy may benefit by transition to renewable energy sources, or how climate change itself could bring benefits. These frames lend themselves well to this analysis as each was used in reports of the coral bleaching although somewhat differently given the context of the event. For example, scientists quoted in the reports initially expressed *uncertainty* over the extent of coral bleaching and death but gradually expressed *greater certainty* in numerical terms as they discovered what occurred; many scientists and others said that the bleaching was *disastrous* for the reef with some even expressing emotions over it such as anger and sadness; still others expressed that billions of tourism dollars were *explicitly at risk* if the reef was not protected from climate change; and others expressed *opportunities* for helping the reef. Also, some reports expressed *skepticism* about the event itself or the role of human-induced climate change in its occurrence, saying that the bleaching was natural and the reef would recover. Other reports mentioned how the federal government had censored a chapter on climate change risks to the GBR in a UNESCO report titled *World Heritage and Tourism in a Changing Climate* (Steffen, 2016).

To define scientific uncertainty more specifically, Weiss (2003) said that it refers to "the likelihood that a given scientific proposition will 'turn out to be true' upon further research" (p. 26). Scientists may express uncertainty about something when they lack information about it or disagree about what is known or can be known (Painter, 2013). In the case of the 2016 coral bleaching, scientists initially lacked information about the extent of bleaching and coral death. As found in several studies on climate change, the uncertainty frame often works against those trying to halt GHG emissions by frustrating those who do not understand scientific uncertainty, turning off readers who believe that they should not waste time reading about things that are not certain, and by giving skeptics room to argue for delaying climate change action since why should people act if impacts are uncertain and distant in time or place. In a UK focus group study, Shuckburgh, Robison, and Pidgeon (2012) found that some participants felt "frustrated or even angry" when they encountered uncertain words such as "could," "may," and "suggest" (p. 30), and in a US study, Moser and Dilling (2004) found that when an uncertainty message is presented early in an article, "listeners [gain] the permission to dismiss or turn attention away from what follows." As the coral bleaching event was happening in real time and not in a faraway future, the uncertainty frame may not in this case have turned readers off.

When using the disaster/implicit risk frame, journalists discuss climate change as broad or particular effects such as melting icecaps or death of reefs, or as impacts upon people such as deaths from heatwaves (Painter, 2013). According to studies by Moser and Dilling (2007) and

O'Neill and Nicholson-Cole (2009), messages of alarm or fear are more likely to reduce people to inaction by making them feel powerless or increasing their disbelief than encouraging them to act to address climate change. People who receive alarm or fear messages are more likely to do nothing or disbelieve if no action strategy is provided to reduce the risk.

The explicit-risk frame refers to phrasing in which "the word 'risk' is used, or where the odds, probabilities or chance of something adverse happening is given, or the inclusion of everyday risk concepts or language like insurance or betting" (Painter, 2013, p. 59). Beck (2013) defined risk as the "anticipation" of a catastrophe, or a future calamity that could occur (p. 9). The 2016 coral bleaching event may be viewed as a singular catastrophe or as the taste of a much larger catastrophe to come, which would be death to much or all of the GBR as well as other climate change impacts. The language of explicit risk is familiar to many people including those in business and the military, those making choices about medical treatment, and those buying home insurance (Painter, 2013). As part of their practice, businesses and the military regularly conduct risk assessments to protect themselves from uncertainty so are well aware of the benefits of discussing risk in explicit terms. Regarding loss to Australia if damage to the GBR continues, Deloitte Access Economics (2017, p. 13), as commissioned by the Great Barrier Reef Foundation, valued the reef at $56 billion AU in present dollars to the year 2050 to "effectively inform policy setting and help industry, government, the scientific community and the wider public understand … [the reef's] contribution… to the economy and society." The valuation therefore aimed to provide Australians with an explicit understanding of what is at risk if the reef is not protected. Deloitte (2017) also reported that the GBR "contributed $6.4 billion [AU] in value added and over 64,000 jobs to the Australian economy in 2015–16 (direct and indirect)" mostly through tourism but also "from fishing, recreational and scientific activities" (p. 7). The monetary value does not include the significance that Traditional Owners' place on the reef or the "natural capital" that the reef provides in ecosystem services such as producing food, maintaining water quality, providing a fisheries habitat, and protecting the Queensland coast from storms. Although the Deloitte researchers gave the reef a monetary value, they emphasized that it is a truly priceless asset, that the many benefits it brings are immeasurable.

Although stories about coral bleaching may be frightening and cause people to turn away from the issue, many researchers believe that the explicit-risk frame is the most honest way to report on this topic as the frame presents the best available information in terms that allow people to understand what is at stake so that they may prepare for potential losses. For example, Nicholas Stern (2007) used this frame in *The Stern Review: The Economics of Climate Change*, when he wrote the following:

> [I]f we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more.
>
> In contrast, the costs of action … can be limited to around 1% of global GDP each year. (p. vi)

Finally, when journalists use the opportunity frame, they discuss climate change in at least two ways. Firstly, they may discuss how climate change has opened the possibility of moving towards "cleaner, safer, more bio-diverse sources of energy or low-carbon development" (Painter, 2013, p. 59), and secondly, they may discuss how not addressing climate change may help the world by, for example, having a longer agricultural growing season in some countries or by opening new shipping routes through the Arctic. In this study, the opportunity frame was defined somewhat differently for the context of the coral bleaching. Here it was defined as actions, plans and recommendations to help the reef, which could include opportunities for moving to sustainable sources of energy.

In Painter's (2013) study of these four frames in climate change reporting across the six countries of Australia, France, India, Norway, the United Kingdom, and the United States, the most commonly used and salient frame was that of implicit risk/disaster. The study consisted of a content analysis of the four frames used in media reports during four different time periods when Intergovernmental Panel on Climate Change (IPCC) reports were released. The implicit risk/disaster frame appeared in "more than 80% of the articles" (Painter, 2013, p. viii) across all these countries; was salient, as measured by its use in the headline or first few lines, in 44% of the articles; and was dominant in 56% of the articles (Painter, 2013, p. 72). The second most common frame was that of uncertainty. It appeared in "nearly 80% of the articles" (p. viii) but was salient in only 16% and dominant in 24% (Painter, 2013, p. 72). The third most common frame was that of opportunity, appearing in 27% of the articles. This frame was salient in 7% of the articles and dominant in 12%. Stories using the frame were mostly about opportunities available from doing nothing to reduce GHGs. Less than two percent of articles mentioned benefits of moving the economy to low-carbon. The least common and least salient frame was that of explicit risk, which was present in 26% of the articles, salient in 5%, and dominant in 14%.

In the specifically Australian part of the research, which was conducted by McGaurr and Lester (2013), 61 articles in the *Australian*, the *Herald Sun*, and the *Sydney Morning Herald* were examined. Across these newspapers, the uncertainty frame appeared in 89% of the articles, the implicit risk frame in 87%, the explicit risk frame in 44%, the skeptical uncertainty frame in 33%, and the opportunity frame in 7%. The salience and dominance of the different frames across the six outlets was as follows: implicit risk was salient in 56% of the articles and dominant in 49%, the uncertainty frame was salient in 21% of the articles and dominant in 25%, the explicit risk frame was salient in 5% of the articles and dominant in 11%, and the opportunity frame was not salient in any article but was dominant in 2%. Skeptical uncertainty was salient in 18% of articles and dominant in 13%. Followed by the United States, skeptical uncertainty was more strongly present in Australia than any other country (Painter, 2013).

3. Research method

The research process for this study followed the steps of a content analysis as described by Pettey, Bracken, and Babin (2017, p. 129): (1) "identify research questions," (2) "conceptualize and identify units of analysis," (3) select texts and create sample, (4) "identify and implement coding process," (5) "determine reliability and validity," and (6) "analyze results." The research questions were to determine how the 2016 mass coral-bleaching event was framed in Australian online news reports in terms of the following frames and subframes: (1) *scientific uncertainty*, which consists of the subframes of *uncertainty* and *greater certainty* about the bleaching impacts; (2) *skepticism*, which consists of the subframes of *greater certainty that the reef will recover quickly* and *skeptical uncertainty* about the bleaching itself, its impacts, its link to greenhouse gases, or censorship of the event; (3) *implicit risk or disaster*; (4) *explicit risk*; and (5) *opportunity*, which refers to actions, plans, proposals, or recommendations by any individual or group including local, state, and federal governments, to help the reef such as halting development of any new coalmines, including the proposed Queensland Adani mine. The reports were also coded for inclusion of scientific information. That is, they were coded for inclusion of direct quotes from scientists or information from scientific reports and whether scientific explanations of the bleaching process were included. The unit of analysis consisted of reports written about the coral bleaching in online news outlets during the two periods when the GBRMPA (2017) was formally assessing the impact: March through June and September through November 2016. Only written text was analyzed. Texts were located by searching the term "coral bleaching" in the *Australian*, the *Courier Mail*, the *Townsville Bulletin*, the *Sydney Morning Herald* (*SMH*), the *ABC* news online, and the *Guardian* Australia edition using each outlet's online search tool. In total, 224 reports were analyzed as follows: 16 (7%) from the *Australian*, 38 (17%) from the *Courier Mail*, 26 (12%) from the *Townsville Bulletin*, 50 (22%) from the *SMH*, 43 (19%) from the *ABC*, and 51 (23%) from the *Guardian*. All reports were downloaded and printed prior to analysis.

Although large audiences still read print media, online news outlets were selected for study because many people, especially younger, prefer online versions, and more climate-change related reports are available in online than print versions (Painter, 2013). Also, online versions allow more space to provide detail. The particular outlets were selected as they offer local, state, interstate, and national perspectives on events and have different political leanings and readership. The outlets were therefore thought to provide a comprehensive sample of frames used to report the 2016 coral-bleaching event. The *Australian, Courier Mail*, and *Townville Bulletin* are all owned by Murdoch's News Corp, which tends to align right-of-center. Both the online and print versions of these outlets are available by subscription only. The *Australian* is a national newspaper that had 1.756 million people read or access content via the web or an app in 2016 (Roy Morgan, 2017). It is "the country's only national generalist newspaper" (McGaurr & Lester, 2013, p. 81) and has strong influence "within the political class … and among other newspapers" owned by News Ltd. Australia including the *Courier Mail* (McGaurr & Lester, 2013: 82). Next, the *Courier Mail* is a tabloid that has the largest circulation in Queensland and had 1.344 million people read or access content via the web or an app in 2016 (Roy Morgan, 2017). The *Townsville Bulletin* serves Townsville, which lies along the GBR and is a popular tourist destination, as well as much of northern Queensland (News Corp Australia, 2018). In 2016, it had a Monday–Friday readership of 43,000 and a Saturday readership of 55,000. The *SMH*, owned by Fairfax Media at the time of this study and operating out of New South Wales, tends to align left-of-center, and is also available by subscription only. It had 3.644 million people read or access content via the web or an app in 2016. Fairfax has since merged with Nine Entertainment. Owned by the government, *ABC NEWS and current affairs* online reached an average 4.7 million visitors each month in 2016–2017 (ABC, 2017, p. 52) and claims to be "Australia's most trusted broadcaster" (ABC, 2017, p. 4). Lastly, according to its website, the *Guardian* Australia edition reaches nearly 2 million readers each month and "consistently ranks among the top 10 news websites in Australia" (Guardian Australia advertising, 2014, p. 1).

The coding instrument used in this study appears in Appendix A. It is an adaptation of Painter's (2013) study of uncertainty and risk reporting across six countries as previously mentioned. Reports were coded for the presence, salience, and dominance of each frame and subframe within them and for the presence of scientific information regarding the bleaching. Salience was coded according to mention of the frame or use of certain words or phrases in the headline or first few lines. Presence of the frame was coded according to mention of it or use of key words or phrases anywhere in the article. Dominance of the frame was coded by greater mention of it or use of key words or phrases throughout the article and a key quote from the article. To establish whether articles included any scientific information, articles were also coded for whether the first person quoted was a scientist or whether the first information to which the article referred was a scientific report, and whether the article provided an explanation of the physical process by which coral bleaching and death occurs.

Table 1 presents example mentions from the reports that reflect the different frames as well as example quotes from scientists that reflect the frames and words or phrases that indicate the presence of each of the frames. For the subframe *greater certainty about the extent of bleaching*, the presence of numbers, percentages, and dates about the bleaching were also coded, and for the subframe *implicit risk/disaster*, quotes in which scientists expressed negative emotions were coded.

Two researchers coded the articles. Following Lombard, Snyder-Duch, and Bracken (2002), 50 articles (22%) were sampled for reliability testing. Also, following Feng (2015), two indices of reliability were used since some variables involved easier coding (e.g. Scientists, scientific organization, or scientific report was quoted or mentioned first) and some involved more difficult coding (e.g. Frame and sub-frame dominance). Therefore, as calculated using percent agreement (P_o), which is a more liberal index, and Krippendorff's alpha (α), which is a more conservative index, the intercoder-reliability for each of the variables is as follows:

Table 1. Examples of frame indicators

Frame	**Scientific uncertainty**		**Skepticism**		**Disaster/implicit risk**	**Explicit risk**	**Opportunity**
Sub-frame	***Uncertainty***	***Greater certainty about the extent of bleaching or coral death***	***Greater certainty that the coral will recover soon***	***Skeptical uncertainty including censorship***			
Mention that reflects the frame	"Scientists will deploy across the Great Barrier Reef … to examine the extent of current coral bleaching."	"Authorities monitoring the Great Barrier Reef Marine Park have increased the coral bleaching threat level after divers found widespread loss of coral."	"Tour boss says reef will renew."	"Tourism bosses have slammed the 'hysteria' over coral bleaching on the Great Barrier Reef. Fred Ariel, who operates tours to Fitzroy Island, has challenged reef scientists to show any significant bleaching on the fringing coral at the popular snorkelling site"; "Several major operators … have refused the party's request to ferry the senators and their entourage offshore to observe 'badly bleached' coral, fearing it could damage tourism."	"Australia's environment ministers have all agreed that the coral bleaching on the Great Barrier Reef 'is alarming' and that 'strong and urgent action is needed on climate change.'"	"QLD Mayors and Premiers should be focused on protecting our Reef and the fishing and tourism it supports, which are worth almost $6 billion a year to Queensland's economy."	"A Labor government would spend an extra $380 million protecting the Great Barrier Reef from climate change."

(*Continued*)

Table 1. (*Continued*)

Frame	**Scientific uncertainty**		**Skepticism**		**Disaster/implicit risk**	**Explicit risk**	**Opportunity**
Sub-frame	***Uncertainty***	***Greater certainty about the extent of bleaching or coral death***	***Greater certainty that the coral will recover soon***	***Skeptical uncertainty including censorship***			
Quotes from scientists or reference to scientific reports	"It is still too early to tell what the full impacts will be in terms of how many bleached coral will actually die."	"The evidence suggests that we are likely to lose most corals worldwide in as little as 30 to 40 years if we continue to warm the climate at current rates."	"Seventy-five per cent of the reef will come out in a few months time as recovered."	"Current reports of coral bleaching on the GBR do not equate to a mass bleaching event."	"In my view we are precipitating the conditions for a mass extinction."	"Along with visitor numbers, the potential loss of tourism revenue represents almost one-third of the $3.3 billion spent by holiday visitors to reef regions each year, which supports between 39,000 and 45,000 jobs … Around 10,000 jobs are at risk … if severe coral bleaching of the reef continues."	"Bleaching is a vivid reminder of the need for all of us to continue building the resilience of coral reefs to give them the best chance of dealing with increasing climate change impacts."
Numbers or dates indicating greater certainty	n.a.	"A couple of weeks ago you'd look around in the Lizard Island lagoon and see at least 50 per cent of corals were stressed to some level, but none had died."	n.a.	n.a.	n.a.	n.a.	n.a.

(*Continued*)

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Table 1. (*Continued*)

Frame	**Scientific uncertainty**		**Skepticism**		**Disaster/implicit risk**	**Explicit risk**	**Opportunity**
Sub-frame	***Uncertainty***	***Greater certainty about the extent of bleaching or coral death***	***Greater certainty that the coral will recover soon***	***Skeptical uncertainty including censorship***			
Word or phrase presence	"uncertain"; "unknown"; "we don't know"; "unclear"; "too early"	n.a.	"is resilient"; "usually recovers"	"doubtful"; "doubt"; "disputed"; "exaggerated"; "censored reports"; "bleaching is natural"	"mass extinction"; "catastrophic" or "catastrophe"; "disaster" or "disastrous"; "existential threat"; "alarming"; "severe"; "emergency"	"risk"; "chances"; "odds"; "insurance"; and numbers describing any potential economic loss	"plan"; "action"; "need"; "funding"
Quote from scientist expressing negative emotion	n.a.	n.a.	n.a.	n.a.	"For me, personally, it was devastating to look out of the chopper window and see reef after reef destroyed by bleaching. But really the emotion is not so much sadness as anger."	n.a.	n.a.

- Scientist, scientific organization, or scientific report was quoted or mentioned first, P_o = .98, α = .96
- Presence of scientific explanation of the bleaching process, P_o = .92, α = .72
- Frame and sub-frame salience, P_o = .90, α = .90
- Frame salience when the two pairs of sub-frames were joined into two frames, P_o = .90, α = .90
- Presence of uncertainty frame, P_o = .90, α = .79
- Presence of greater certainty of extent of coral bleaching or mortality frame, P_o = .90, α = .72
- Presence of greater certainty of reef recovery frame, P_o = .90, α = .80
- Presence of skeptical uncertainty frame, P_o = .90, α = .76
- Presence of implicit risk/disaster frame, P_o = .94, α = .82
- Presence of explicit risk frame, P_o = .96, α = .73
- Presence of opportunity frame, P_o = .90, α = .80
- Frame and sub-frame dominance, P_o = .90, α = .88
- Frame dominance when the two pairs of subframes were joined into two frames, P_o = .94, α = .93

For the variables in this study, percent agreement ranged from .90 to .98 and α ranged from .72 to .98. For percent agreement, a result of .90 or above is acceptable, and for α, a result of .70 or above is acceptable.

4. Results

Table 2 presents the coding results across the six news outlets.

Looking at Table 2, the *Guardian, SMH*, and *ABC* each published more of the 224 reports on the event than any of the three News Corp outlets. The *Guardian* published 51 reports (23%), followed by the *SMH*, which published 50 reports (22%), and the *ABC*, which published 43 reports (19%). In contrast, the *Courier Mail* published 38 reports (17%), followed by the *Townsville Bulletin, which* published 26 reports (12%). Lastly, the *Australian* published only 16 reports (7%), four of which were editorials.

Considering the six media outlets altogether (see Figure 1), the implicit risk/disaster frame had the highest presence in the reports (82%), followed by greater certainty of event impact (68%), opportunity (46%), skeptical uncertainty (30%), uncertainty of event impact (27%), greater certainty that the coral would recover (19%), and explicit risk (9%).

Next, the implicit risk/disaster frame was most often salient (37%), followed by greater certainty of event impact (19%), opportunity (17%) and skeptical uncertainty (17%), uncertainty (6%), greater certainty that the coral would recover (5%), and explicit risk (3%). When joining the two sets of sub-frames to form the scientific uncertainty and skepticism frames, the implicit risk/disaster frame remained most salient (37%), followed by scientific uncertainty (25%), skepticism (22%), opportunity (17%), and explicit risk (3%).

Finally, the opportunity frame was the most often dominant (27%), followed by greater certainty of event impact (19%), skeptical uncertainty (17%), greater certainty of coral recovery (7%), explicit risk (4%), and uncertainty (3%). When joining the two sets of sub-frames to become the scientific uncertainty and skepticism frames, the opportunity frame remained the most dominant (27%), followed by skepticism (24%), scientific uncertainty (22%), implicit risk/disaster (18%), and explicit risk (4%). As shown, explicit risk had the least presence, and was least often salient or dominant.

Table 2. Results of content analysis

Newspaper	*Australian*		*Courier Mail*		*Townsville Bulletin*		*Sydney Morning Herald*		*ABC*		*Guardian* Australia		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total reports	16	*7%*	38	*17%*	26	*12%*	50	*22%*	43	*19%*	51	*23%*	224	100%
Part of newspaper:														
News reports and features	12	*75%*	35	*92%*	25	*96%*	41	*82%*	43	*100%*	42	*82%*	198	*88%*
Opinion or editorial	4	*25%*	3	*8%*	1	*4%*	9	*18%*	0	*0%*	9	*18%*	26	*12%*
Initial quote or reference:														
Scientist or scientific organization	6	*38%*	11	*29%*	7	*27%*	30	*60%*	23	*53%*	21	*41%*	98	*44%*
Non-scientist:	10	*63%*	27	*71%*	19	*73%*	20	*40%*	20	*47%*	30	*59%*	126	*56%*
Scientific explanation of coral bleaching	1	*6%*	1	*3%*	0	*0%*	14	*28%*	5	*12%*	14	*27%*	35	*16%*
Uncertainty about event impacts	6	*38%*	6	*16%*	7	*27%*	21	*42%*	11	*26%*	9	*18%*	60	*27%*
Salience	0	*0%*	2	*5%*	1	*4%*	2	*4%*	0	*0%*	0	*0%*	5	*2%*
Mention that extent of impact is uncertain	6	*38%*	6	*16%*	7	*27%*	21	*42%*	11	*26%*	9	*18%*	60	*27%*
Quotes from or reference to a scientist(s) or scientific report(s)	2	*13%*	1	*3%*	7	*27%*	15	*30%*	10	*23%*	8	*16%*	43	*19%*
Word presence (e.g. "too early")	6	*38%*	6	*16%*	7	*27%*	21	*42%*	11	*26%*	9	*18%*	60	*27%*
Dominance	1	*6%*	2	*5%*	1	*4%*	1	*2%*	1	*2%*	0	*0%*	6	*3%*
Greater certainty about event impacts	6	*38%*	20	*53%*	12	*46%*	45	*90%*	32	*74%*	45	*88%*	160	*71%*
Salience	0	*0%*	3	*8%*	2	*8%*	14	*28%*	14	*33%*	8	*16%*	41	*18%*
Mention of greater certainty of event impacts	6	*38%*	20	*53%*	12	*46%*	37	*74%*	32	*74%*	45	*88%*	152	*68%*

(*Continued*)

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Table 2. (*Continued*)

Newspaper	*Australian*		*Courier Mail*		*Townsville Bulletin*		*Sydney Morning Herald*		*ABC*		*Guardian* Australia		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Percentages used to explain event impacts	2	*13%*	12	*32%*	9	*35%*	45	*90%*	28	*65%*	44	*86%*	140	*63%*
Quotes from or reference to a scientist(s) or scientific report(s)	5	*31%*	6	*16%*	11	*42%*	32	*64%*	21	*49%*	32	*63%*	107	*48%*
Dominance	0	*0%*	3	*8%*	3	*12%*	19	*38%*	11	*26%*	6	*12%*	42	*19%*
Greater certainty that coral will recover	7	*44%*	18	*47%*	4	*15%*	5	*10%*	3	*2%*	3	*6%*	40	*18%*
Salience	2		7	*18%*	3	*12%*	0	*0%*	0	*0%*	0	*0%*	12	*5%*
Mention of greater certainty that the coral will recover	7	*44%*	18	*47%*	4	*15%*	5	*10%*	3	*7%*	3	*6%*	40	*18%*
Quotes from or reference to a scientist(s) or scientific report(s)	7	*44%*	4	*11%*	3	*12%*	2	*4%*	0	*0%*	2	*4%*	18	*8%*
Dominance	3	*19%*	10	*26%*	2	*8%*	0	*0%*	1	*2%*	0	*0%*	16	*7%*
Skeptical uncertainty including event censorship	9	*56%*	19	*50%*	12	*46%*	7	*14%*	5	*12%*	16	*31*	68	*30%*
Salience	9	*56%*	12	*32%*	10	*38%*	0	*0%*	4	*9%*	4	*8%*	39	*17%*
Quotes from or reference to a scientist(s) or scientific report(s)	1	*6%*	1	*3%*	2	*8%*	0	*0%*	3	*12%*	4	*8%*	11	*5%*
Mention of skeptical uncertainty including censorship	9	*56%*	19	*50%*	12	*42%*	7	*14%*	5	*12%*	16	*31%*	68	*30%*
Dominance	9	*56%*	11	*29%*	9	*35%*	0	*0%*	4	*9%*	5	*10%*	38	*17%*
Implicit risk/disaster	15	*94%*	27	*71%*	15	*58%*	41	*82%*	34	*79%*	51	*100%*	183	*82%*
Salience	4	*25%*	7	*18%*	4	*15%*	27	*54%*	15	*35%*	26	*51%*	83	*37%*

(*Continued*)

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Table 2. (*Continued*)

Newspaper	*Australian*		*Courier Mail*		*Townsville Bulletin*		*Sydney Morning Herald*		*ABC*		*Guardian* Australia		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Scientist expresses negative emotion about event	3	*19%*	7	*18%*	1	*4%*	22	*44%*	10	*23%*	19	*37%*	62	*28%*
Quotes from or reference to a scientist(s) or scientific report(s)	8	*50%*	8	*21%*	8	*31%*	24	*48%*	19	*44%*	33	*65%*	100	*45%*
Word presence	15	*94%*	27	*71%*	15	*58%*	41	*82%*	34	*79%*	51	*100%*	183	*82%*
Dominance	2	*13%*	5	*13%*	3	*12%*	17	*34%*	12	*28%*	12	*24%*	51	*23%*
Explicit risk	0	*0%*	2	*5%*	4	*15%*	3	*6%*	2	*5%*	9	*18%*	20	*9%*
Salience	0	*0%*	1	*3%*	2	*8%*	1	*2%*	1	*2%*	1	*2%*	6	*3%*
Quotes from or reference to a scientist(s) or scientific report(s)	0	*0%*	1	*3%*	2	*8%*	3	*6%*	2	*5%*	2	*4%*	10	*4%*
Word presence	0	*0%*	2	*5%*	4	*15%*	3	*6%*	2	*5%*	9	*18%*	20	*9%*
Dominance	0	*0%*	1	*3%*	2	*8%*	2	*4%*	1	*2%*	4	*8%*	10	*4%*
Opportunity	1	*6%*	11	*29%*	8	*31%*	25	*50%*	21	*49%*	38	*75%*	103	*46%*
Salience	1	*6%*	6	*16%*	4	*15%*	6	*12%*	9	*21%*	12	*24%*	38	*17%*
Mention of opportunities to help the reef	0	*0%*	11	*29%*	8	*31%*	25	*50%*	21	*49%*	38	*75%*	103	*46%*
Quotes from scientist(s) or reference to scientific report(s)	0	*0%*	1	*3%*	1	*4%*	8	*16%*	8	*19%*	16	*31%*	34	*15%*
Dominance	1	*6%*	6	*16%*	6	*23%*	11	*22%*	13	*30%*	24	*47%*	61	*27%*

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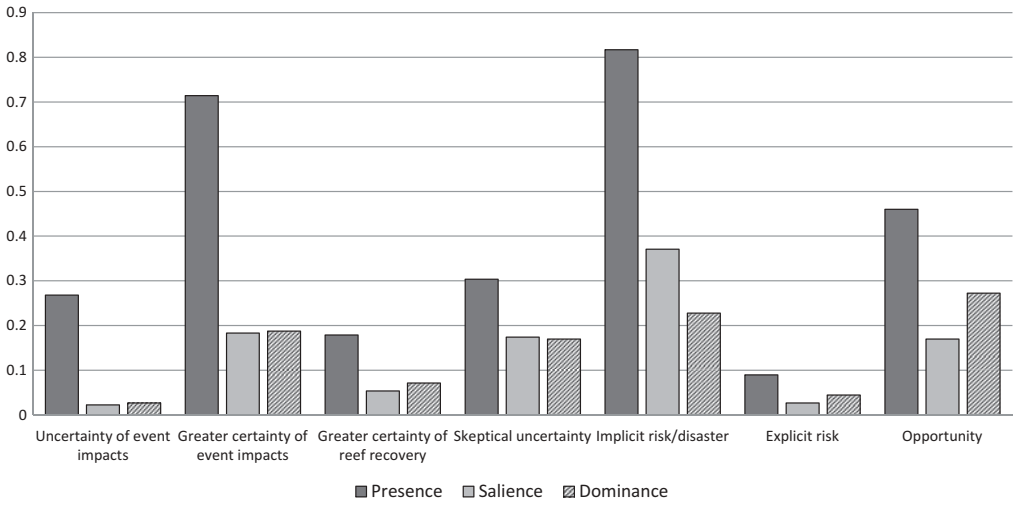

Figure 1. Presence, salience, and dominance of frames and sub-frames across six Australian online news outlets.

The *SMH, ABC*, and *Guardian* also each took a more scientific position on their reports than did the News Corp outlets as measured by number of reports containing a detailed scientific explanation of the bleaching process and quoting a scientist or referring to a scientific group or report first. The *SMH* explained the bleaching process in 14 (28%) of its reports, the *Guardian* explained it in 14 (27%) of its reports, and the *ABC* explained it in 5 (12%) of its reports. In contrast, the *Australian* and the *Courier Mail* published just one report each that explained how coral bleaching and death occurs, and the *Townsville Bulletin* published no reports explaining the bleaching process. Regarding who or what was quoted or mentioned first in a report, the *Australian, Courier Mail* and *Townsville Bulletin* each quoted or mentioned a scientist, scientific organization, or scientific report less often than the other outlets: the *Courier Mail* referred to science first in 11 (29%) of its reports, the *Australian* referred to science first in 6 (38%) of its reports, and the *Townsville Bulletin* referred to science first in 7 (27%) of its reports. In contrast, 30 (60%) of the *SMH* articles referred to science first, 21 (53%) of the *ABC* reports referred to science first, and 21 (41%) of the *Guardian* reports referred to science first.

Figure 2 shows the percentage of reports in each outlet in which each of the frames was salient. In this figure, scientific uncertainty is the sum of the uncertainty of event impacts and greater certainty of impacts frames, and skepticism is the sum of the greater certainty of coral recovery

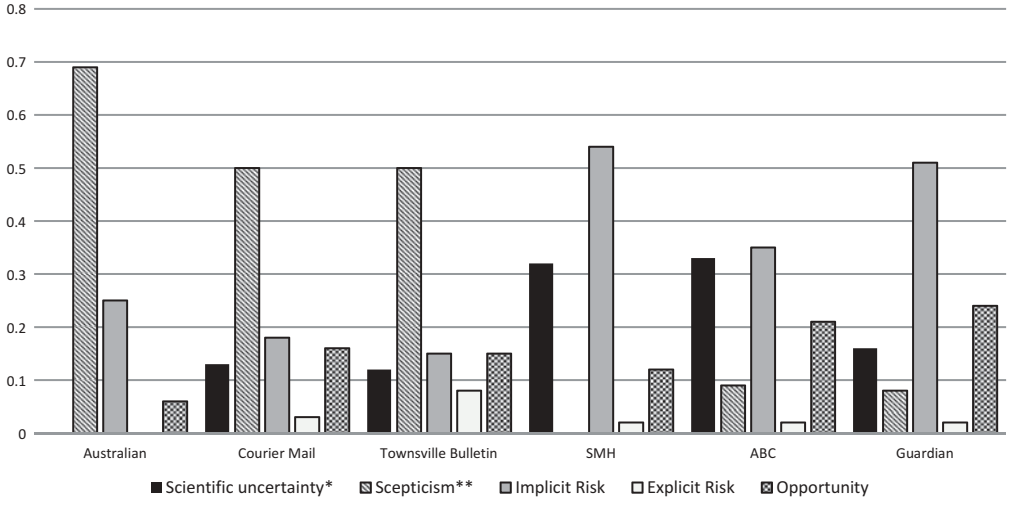

Figure 2. Percentage of reports in each outlet in which each frame is salient.

(**Scientific certainty* is the sum of the *uncertainty of event impacts* and *greater certainty of impacts* frames;
***Skepticism* is the sum of the *greater certainty of coral recovery* and *skeptical uncertainty* frames)

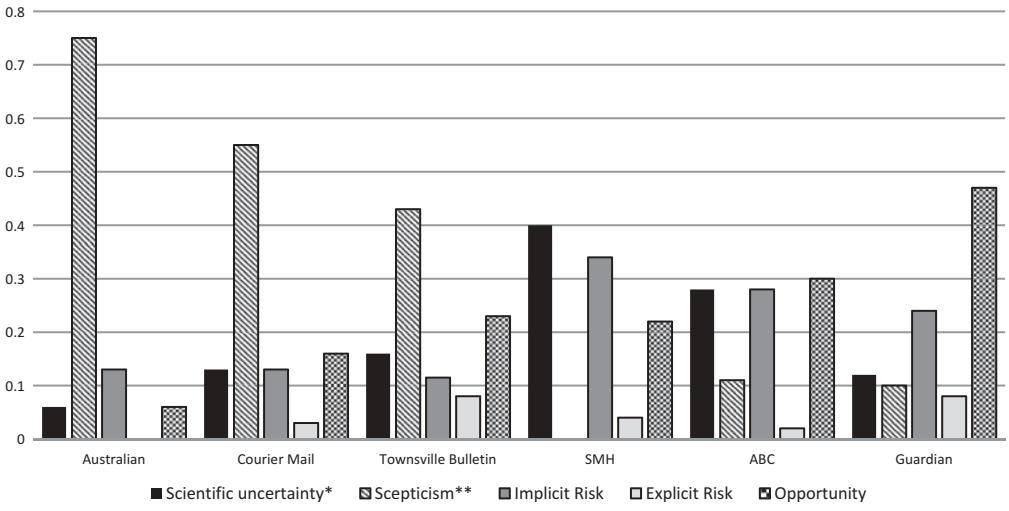

Figure 3. Percentage of reports in each outlet in which each frame is dominant.

(*Scientific certainty is the sum of the uncertainty of event impacts and greater certainty of impacts frames;
**Skepticism is the sum of the greater certainty of coral recovery and skeptical uncertainty frames)

and skeptical uncertainty frames. Figure 3 shows the percentage of articles in which each of the frames was dominant.

As shown, skepticism was most salient and dominant in the *Australian, Courier Mail*, and *Townsville Bulletin*. In the *Australian*, it was salient in 69% and dominant in 75% of the reports. In the *Courier Mail*, it was salient in 50% and dominant in 55% of the reports, and in the *Townsville Bulletin*, it was salient in 50% and dominant in 43% of the articles.

Scientific uncertainty was most salient and dominant in the *SMH* and *ABC* reports. In the *SMH*, it was salient in 32% of the reports and dominant in 40%. In the *ABC*, it was salient in 33% of the reports and dominant in 28%.

The implicit risk/disaster frame was most salient and dominant in the *SMH* followed by the *Guardian* and *ABC*. In the *SMH*, this frame was salient in 54% of its reports and dominant in 34%. In the *Guardian*, implicit risk/disaster was salient in 51% of reports and dominant in 24%. Finally, in the *ABC*, this frame was salient in 33% of its reports and dominant in 28%.

The opportunity frame as defined in this research was most salient and dominant in the *Guardian* reports followed by those of the *ABC*. For the *Guardian*, it was salient in 25% and dominant in 51% of the reports.

Although the explicit risk frame was little used in any outlet, it was used more often in the *Townsville Bulletin* than the other outlets. In the *Townsville Bulletin*, it was salient and dominant in 8% of the reports.

5. Discussion

Although different outlets were analyzed, it is still possible to make some comparisons between the McGaurr and Lester (2013) study of IPCC reporting in the Australian media, which was presented earlier, and this study regarding the salience and dominance of the different uncertainty and risk frames in media reporting of the 2016 coral bleaching. In both studies, the implicit risk/disaster frame had the highest salience (IPCC—56%; coral bleaching—37%), followed by scientific uncertainty (IPCC—21%; coral bleaching—25%), then skepticism (IPCC—18%; coral bleaching—22%), and explicit risk (IPCC—5%; coral bleaching—3%).

The frequency with which the different frames dominated in Australian media reports generally differed between the two studies. While the frequency of dominance in the IPCC reports generally followed the same pattern as their frequency of salience (e.g. implicit risk/disaster had the highest salience (49%) while opportunity had the lowest salience (2%)), the frequency of dominance of the different frames was flatter across the coral-bleaching reports with the exception of explicit risk. Explicit risk was low in dominance in both the IPCC reports (11%) and this study of coral-bleaching reports (4%), which indicates that use of this frame for climate change reporting may unfortunately have remained low from 2013 to 2016. Regarding the skepticism frame, its frequency of dominance was even higher in the coral-bleaching reports (24%) than the IPCC reports (13%), which indicates that skepticism of climate change remains strong and active in Australia. However, the high dominance of the opportunity frame (27%) in the coral-bleaching reports indicates that many people are concerned about the reef although they may have different solutions for helping it.

As shown by this study, the Australian media remains polarized regarding climate change. The percentage of reports that contained skepticism was quite high in the News Corp outlets. Also, the smaller number of reports from these outlets indicates that the outlets were censoring the story. As further proof of reporting problems, in April 2016, the Climate Council placed a full-page advertisement signed by 56 scientists in the *Courier Mail* about the bleaching because the scientists assessed that the *Courier Mail* was inadequately covering the event (Slezak, 2016). According to an article in the *Guardian*, scientists placed the ad because they were "fed up with Queensland's biggest newspaper not covering the worst bleaching event to hit the Great Barrier Reef" (Slezak, 2016). Further, Hoegh-Guldberg, who was quoted in the article, said:

> One of the reasons we placed the ad in the *Courier Mail* was that we've seen very little coverage of the coral bleaching event in that paper and in fact there was a front-page story that said the coral bleaching event had been wildly exaggerated. (Slezak, 2016)

Considering the results of this study, it is important to ask why Australian media reports on the coral bleaching were polarized since climate-change reports are not polarized in all countries. In Sweden, for example, the media present climate science as certain (Olausson, 2009). It is also largely presented as certain in Brazil, France, and India (Painter, 2011). However, reports are polarized in the United States and the United Kingdom (Painter, 2011). Although many factors may explain polarization, Painter concluded the following:

> In the UK and USA there is strong evidence for seeing a close correspondence between the prevalence of sceptical voices and the political ideology … of a newspaper… climate scepticism is mainly a feature of a … narrow strand of conservative ideology (libertarian and strongly free-market). (Painter, 2011, pp. 111–112)

In Brazil, France, and India, "there are no conservative parties or significant elements within them who energetically follow … [the] type of conservative ideology whom the (right-leaning) print media can quote" (Painter, 2011, p. 112). In other words, if no significant groups exist that choose to promote a skeptical climate-change response, the media is not polarized.

Painter (2011) noted that there may be additional reasons for polarized media such as newspaper editor and owner influences, "a country's energy profile, the presence of web-based skepticism, and a country's direct experience of a changing climate" (p. 113). In Australia, factors that may have driven the skeptical stories of coral bleaching are the political ideology of News Corp; a conservative government (Liberal Party in power from 1996 to 2007 and 2013 to present); conservative think tanks (e.g. the Institute of Public Affairs); skeptical bloggers (e.g. The Australian Climate Sceptics Blog); coal being Australia's second largest export commodity (Origin, 2017) worth about $38 billion AU and constituting about 13% of the country's 2012–2013 exports (Minerals Council of Australia, 2017); Australia relying on coal for 73% of its electricity generation (Origin, 2017); and fear that tourists would stop coming to the reef if they thought it was bleached or dead.

This research also shows that when climate-change disaster actually affected the country's precious asset of the Great Barrier Reef, the dominant groups chose to continue expressing skepticism in the media and to begin censoring reports about the event rather than admit that climate change caused a serious problem and act to prevent future damage. As Beck (2013) noted, a climate change "'accident' has no limits in time and space, it becomes an event with a beginning but without an end, an 'open-ended festival' of creeping, galloping, and overlapping waves of destruction" (p. 28).

6. Conclusion

To improve prospects for the reef, it is recommended that all newspapers but especially the *ABC*, which is freely available nationwide, use the explicit-risk frame instead of the other frames to more frequently report on how the GBR is being affected by climate change. These stories need to be explicitly about climate change effects on the reef, not other reef issues because if many issues are discussed in one story, the argument about climate change damage could become lost or muddied. The *ABC* and other newspapers could also use the opportunity frame to provide examples of specific actions that people and particularly the government need to take to protect the reef from climate change. Also, the number of people in Australia who understand the link between coral bleaching and worldwide GHG emissions needs to increase. As found by a nationally representative Ipsos (2017) survey, only 47% of Australians believe that the GBR has already been impacted by climate change.

As recommended by Painter (2013), scientists also need to explain early-on in media interviews the broad scientific consensus that humans are causing climate change and that therefore humans are responsible for mass coral bleaching events. Further, scientists should discuss early-on in interviews any reef and climate change issues that are more certain so that people do not become frustrated with uncertainty and turn off. Next, both scientists and journalists need training in how to use the explicit risk frame. Also, journalists should receive more training in number and probabilities to better report risks, and more research should be conducted on how best to report coral bleaching and other climate change risks and current damage to the public.

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Appendix A. Coding instrument

Newspaper: _____ Article title: _____

Date of article: _____ Researcher: _____

(1) In which part of the newspaper did the article appear?
- ☐ News reports and features
- ☐ Opinion or editorial (OpEd)

(2) Which frame is most salient in the headline or first few lines?
- ☐ Uncertainty (e.g. "unknown")
- ☐ More certainty (e.g. "likely")
- ☐ Greater certainty that the reef will recover
- ☐ Skeptical: (e.g. "doubtful")
- ☐ Implicit risk/disaster (e.g. alarming, disastrous consequences)
- ☐ Explicit risk (e.g. numeric chances of losses with dates and the word "risk")
- ☐ Opportunity (e.g. what can be done to help the reef)

(3) Who is the first person or group quoted or mentioned in the article?
- ☐ A scientist or scientific research group, or author is a scientist: _____
- ☐ A politician or government official, or the government itself: _____
- ☐ A conservationist or conservation group (e.g. Greenpeace): _____
- ☐ A tourist: _____
- ☐ A tourism operator or group: _____
- ☐ A broadcaster or journalist: _____
- ☐ A mining group: _____
- ☐ A celebrity: _____
- ☐ UNESCO or a UNESCO official: _____
- ☐ Other: _____

(4) Did the article explain in detail the physical process by which coral bleaching occurs?
- ☐ Yes
- ☐ No

(5) Indicators of the uncertainty frame:
- (i) Did the article contain any mention that the extent of bleaching or coral death was unknown?
  - ☐ Yes
  - ☐ No
- (ii) Did the article contain direct quotes from scientists mentioning uncertainty?
  - ☐ Yes
  - ☐ No
- (iii) Did the article contain terms such as “uncertain”; “unknown”; “we don’t know”; “unclear”; “too early”?
  - ☐ Yes
  - ☐ No

(6) Indicators of the greater certainty of the extent of bleaching frame:
- (i) Did the article contain any mention that the extent of bleaching or coral death was more certain?
  - ☐ Yes
  - ☐ No
- (ii) Did the article contain direct quotes from scientists mentioning greater certainty about the extent of bleaching?
  - ☐ Yes
  - ☐ No
- (iii) Did the article provide any numerical quantities, percentages or dates to explain coral bleaching or climate change impacts on the reef?
  - ☐ Yes
  - ☐ No

(7) Indicators of the greater certainty of reef recovery/resilience frame:
- (i) Did the article contain any mention that the reef will recover quickly from the bleaching (e.g. within a few months)?
  - ☐ Yes
  - ☐ No
- (ii) Did the article contain direct quotes from scientists mentioning greater certainty that the reef will recover?
  - ☐ Yes
  - ☐ No
- (iii) Did the article contain phrases such as “the reef is resilient”; “the reef usually recovers”
  - ☐ Yes
  - ☐ No

(8) Indicators of the skeptical frame:
- (i) Did the article contain any mention that the coral bleaching reports are alarmist or misleading, that bleaching is not happening, or that the government or others are censoring the bleaching?
  - ☐ Yes

☐ No

(ii) Did the article contain direct quotes from scientists mentioning skepticism or denigrating climate science?

☐ Yes

☐ No

(iii) Did the article contain terms such as "doubtful"; "doubt"; "disputed"; "exaggerated" or phrases such as "coral bleaching is completely natural or minimal or caused by El Nino"?

☐ Yes

☐ No

(9) Indicators of the implicit risk/disaster frame:

(i) Did the article contain any mention that the coral bleaching is disastrous for the reef?

☐ Yes

☐ No

(ii) Did the article contain direct quotes from scientists mentioning implicit risks or disastrous consequences for the reef?

☐ Yes

☐ No

(iii) Did the article contain direct quotes from scientists in which they expressed negative emotions (e.g. sadness, shock, worry, anger, fear) about what was happening on the reef?

☐ Yes

☐ No

(iv) Did the article contain terms such as "mass extinction"; "catastrophic" or "catastrophe"; "disaster" or "disastrous"; "existential threat"; "alarming"; "severe"; or "emergency"?

☐ Yes

☐ No

(10) Indicators of the explicit risk frame:

(i) Did the article contain direct quotes from scientists that used the words "risk" or "insurance" along with numerical probabilities or timelines of physical, economic, or other potential losses regarding the reef?

☐ Yes

☐ No

(ii) Did the article contain statements that use the words "risk" or "insurance" along with numerical probabilities or timelines of physical, economic, or other potential losses regarding the reef?

☐ Yes

☐ No

(11) Indicators of the opportunity frame:

(i) Did the article contain direct quotes from scientists that described actions needed to be taken or that have been taken to support the reef from coral bleaching?

☐ Yes

☐ No

(ii) Did the article contain statements describing actions that needed to be taken or that were being taken to support the reef from coral bleaching?

☐ Yes

☐ No

(iii) Example: _____

(12) Dominant tone:

☐ Uncertainty

☐ More certainty

☐ Greater certainty that the reef will recover

☐ Skepticism

☐ Implicit risk/disaster

☐ Explicit risk

☐ Opportunity

(i) Key quote/phrase to prove dominant tone:

_____

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